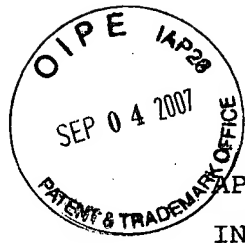APPLICATION NO.   09/826,118

TITLE OF INVENTION: Wavelet Multi-Resolution Waveforms

INVENTOR: Urbain A. von der Embse

Clean version of how the CLAIMS will read.

APPLICATION NO. 09/829,118

INVENTION: Wavelet Multi-Resolution Waveforms

INVENTORS: Urbain A. von der Embse

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CLAIMS

WHAT IS CLAIMED IS:

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　　　Claim 1. (deleted)

　　　Claim 2. (deleted)

　　　Claim 4. (deleted)

　　　Claim 5. (deleted_

15　　Claim 6. (deleted)

　　　Claim 7. (currently amended)　A least-squares method for
generating and applying Wavelet waveforms and filters, said
method comprising the steps:

20　said Wavelet is a digital finite impulse response waveform at
　　　baseband in the time domain,

linear phase finite impulse response filter requirements on the
　　　passband and stopband performance of the power spectral
　　　density are specified by linear quadratic error metrics in
25　　the Wavelet,

Wavelet requirements on the deadband for quadrature mirror filter
　　　properties required for perfect reconstruction are
　　　specified by a linear quadratic error metric　in the
　　　Wavelet,

30　Wavelet orthogonality requirements for intersymbol
　　　interference and adjacent channel interference are
　　　specified by non-linear quadratic error metrics in the
　　　Wavelet,

non-linear quadratic error metrics have quadratic coefficients
35　　　dependent on the Wavelet,

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Wavelet multi-resolution property requires said error metrics to
    be converted to error metrics in the discrete Fourier
    transform harmonics of the Wavelet which harmonics are the
    Wavelet impulse response in the frequency domain,
5 using a least-squares recursive solution algorithm with quadratic
    error metrics, which algorithm requires a means to find the
    Wavelet harmonics that minimize the sum of said linear
    quadratic error metrics,
said harmonics are used to linearize said non-linear quadratic
10   error metrics,
said least-squares recursive solution algorithm finds the
    harmonics which minimize the weighted sum of the linear and
    linearized quadratic error metrics,
said least-squares recursive solution algorithm starts over again
15   by using said harmonics to linearize the non-linear error
    metrics and to find the corresponding harmonics which
    minimize the sum of said linear and linearized quadratic
    error metrics,
said least-squares recursive solution algorithm continues to be
20   repeated until the solution converges to the design
    harmonics of the Wavelet which is the least-squares error
    solution, and
said Wavelet impulse responses in the time domain and
    frequency domain are implemented in communication systems
25   for waveforms and filters.

    Claim 8. (currently amended) A second least-squares method
for generating and applying Wavelet waveforms and filters, said
method comprising the steps:
30 linear phase filter requirements on the passband and stopband
    performance of the power spectral density are specified by
    linear quadratic error metrics in the Wavelet impulse
    response in the time domain,
using a least-squares recursive solution algorithm

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with norm-squared error metrics, which algorithm requires
a initialization Wavelet and a means to find the Wavelet
harmonics which minimize the sum of said linear norm-
squared error metrics,

5 said initialization Wavelet is the optimum Wavelet that minimizes
the weighted sum of said linear quadratic error metrics
which optimum Wavelet is found using an eigenvalue, Remez-
Exchange, or other optimization algorithm,

said linear quadratic error metrics are transformed into linear

10   norm-squared error metrics in the Wavelet,

Wavelet requirements on the deadband for quadrature mirror filter
properties required for perfect reconstruction are
specified by a linear norm-squared error metric in the
Wavelet,

15 Wavelet orthogonality requirements for intersymbol interference
and adjacent channel interference are specified by non-
linear norm-squared error metrics in the Wavelet,

non-linear norm-squared error metrics have norm coefficients
dependent on the Wavelet,

20 Wavelet multi-resolution property requires said error metrics to
be converted to error metrics in the discrete Fourier
transform harmonics of the Wavelet which harmonics are the
Wavelet impulse response in the frequency domain,

using said least-squares recursive solution algorithm to find the

25   harmonics that minimize the weighted sum of said least-
squares linear and non-linear norm-squared error metrics,
which harmonics are the design harmonics of the Wavelet
least-squares error solution, and

said Wavelet impulse responses in the time domain and frequency

30   domain are implemented in communication systems for
waveforms and filters.

Claim **9.** (deleted)

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Claim **10**. (currently amended) Wherein applications of the Wavelet
waveforms and filters in claims 7 or 8, comprising:
Discrete Fourier Transform (DFT) defines the mother Wavelet in
        terms of the frequency domain design harmonics in equation
5   (11),
    mother Wavelets for scale and translation parameters are defined
        in terms of the design harmonics in equation (18),
    mother Wavelet design harmonics are defined in terms of the
        Wavelet impulse time response digital samples in equation
10   (20),
    Wavelet design in the frequency domain allows a mother Wavelet to
        be re-scaled for application to multi-channel polyphase
        filter banks by implementing equations (11),(18),(20) which
        derive a multi-resolution Wavelet from a mother Wavelet by
15   using the design harmonics of the mother Wavelet and the
        multi-scale parameters of the Wavelet impulse response for
        said application,
    wherein mother Wavelet refers to a Wavelet at baseband which is
        used to generate other Wavelets,
20   wherein multi-scale parameters are the traditional scale,
        translation, timing parameters, plus frequency, spacing,
        and length parameters of this invention, and wherein
        scale parameter scales time interval between samples,
            sub-sampling, over-sampling, and translation interval
25   between Wavelets,
        translation parameter is the timing offset of the Wavelets
            in units of the spacing parameter,
        timing parameter is the digital sampling interval,
        frequency parameter is a frequency offset which translates
30   the Wavelet in frequency,
        spacing parameter is the number of digital samples for
            Wavelet spacing which is equal to the number of
            channels in a polyphase filter bank with a Nyquist
            sampling rate,
35   length parameter specifies the length of the Wavelet in the

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sampling domain, and

said multi-scale parameters and the mother Wavelet design
harmonics generate the Wavelet for the multi-channel
polyphase filter bank.

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Claim **11**. (deleted)

10   Claim **12**. (currently amended) Wherein properties of Wavelet
waveforms and filters in claims 7 or 8, comprising:
Discrete Fourier Transform (DFT)_ defines the mother Wavelte in
terms of the frequency domain design harmonics in equation
(11),
15   mother Wavelets for scale and translation parameters are defined
in terms of the design harmonics in equation (18),
mother Wavelet design harmonics are defined in terms of the
Wavelet impulse time response digital samples in equation
(20),_
20   said Wavelets are multi-resolution Wavelets which enable a
single Wavelet design at baseband to be used to generate
Wavelets for multi-resolution applications by implementing
equations (11),(18)(20) and using the Wavelet design
harmonics and the multi-scale parameters for the multi-
25   · resolution Wavelet applications,
said Wavelet is designed for a communications waveform with
.no excess bandwidth,
said multi-resolution Wavelets are designed to behave like
an accordion in that at different scales the Wavelet is a
30   stretched or compressed version of the Wavelet,
said linear waveform and filter least-squares design methods are
modified to design non-linear Wavelet waveforms for other
applications including bandwidth efficient modulation and
synthetic aperture·radar, and
35 · other optimization algorithms exist for finding said Wavelets.

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